

EVOLUTION OF GALACTIC FIELD BE STARS

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Abstract. Galactic field Be stars were studied by taking into account the effects induced by the fast rotation on their fundamental parameters. Fractional ages τ/τ_{MS} (τ_{MS} = time spent in the MS) against stellar mass reveal that: a) Be stars spread over the whole interval $0 < \tau/\tau_{\text{MS}} < 1$; b) the Be phenomenon in massive stars ($M > 12M_{\odot}$) is present at smaller age ratios than for less massive stars ($M < 12M_{\odot}$); c) there is a lack of Be stars with $M < 7M_{\odot}$ in the first half of the MS. Low mass fast rotators ($M < 7M_{\odot}$), called Bn stars, could be “becoming” Be stars.

1 Sample and Method

We studied 97 field galactic bright Be stars using the BCD system (Chalonge & Divan 1956, Zorec & Briot 1991) to avoid perturbations on the fundamental parameters due to the circumstellar disc. These parameters were treated for rotational effects (Frémat et al. 2005). From the observed parameters, called *apparent*, we obtain first the *parent non-rotating counterparts* (*pnrc*) which represent homologous stars without rotation. To enter the evolutionary tracks, we transform then the *pnrc* into *averaged* parameters over the whole stellar surface.

2 Results and Conclusions

Figure 1a) shows the distribution of points ($\tau/\tau_{\text{MS}}, M/M_{\odot}$) obtained using the original or *apparent* fundamental parameters and the evolutionary tracks without rotation (Schaller et al. 1992). The plotted error bars correspond to measurement uncertainties. Figure 1b) shows the same type of distribution, but where parameters were corrected for rotational effects assuming rigid rotation with $\Omega/\Omega_{\text{crit}} = 0.9$ (Frémat et al. 2005) and models of stellar evolution with rotation calculated by Meynet & Maeder (2000) with ZAMS equatorial velocity $V_{\text{ZAMS}} = 300 \text{ km s}^{-1}$. In both diagrams of Fig. 1, points spread over the whole interval of age fractions $0 \lesssim$

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$\tau/\tau_{\text{MS}} \lesssim 1$, which suggest that the Be phenomenon may appear at whatever stage of the stellar evolution on the MS evolution phase. There is, however, a difference between the diagrams where rotation is taken into account and where it is not. If we were not aware of rotational effects, Fig. 1a would suggest that 86% of stars are above the $\tau/\tau_{\text{MS}} = 0.5$ limit. Figure 1b shows, however, when fast rotation of Be stars is taken into account, the fraction of stars in our sample above $\tau \simeq 0.5\tau_{\text{MS}}$ slumps to 62%. When we separate the stars into *massive* ($M \gtrsim 12M_{\odot}$) and *less massive* ones ($M \lesssim 12M_{\odot}$) another important result appears: we see in Fig. 1b that the Be phenomenon in massive stars tends to appear on average at smaller τ/τ_{MS} age fractions than in the less massive stars. There is also a striking lack of low-mass Be stars ($M \lesssim 7M_{\odot}$) in $\tau/\tau_{\text{MS}} < 1/2$. These distributions can be due to: *i*) higher mass-loss rates in massive objects, which reduce the surface fast rotation and inhibit the Be phenomenon rapidly; *ii*) circulation time scales to transport angular momentum from the core to the surface, which are longer the lower the stellar mass. Some of low-mass fast rotators, classified as Bn stars, could then be “**becoming**” Be stars.

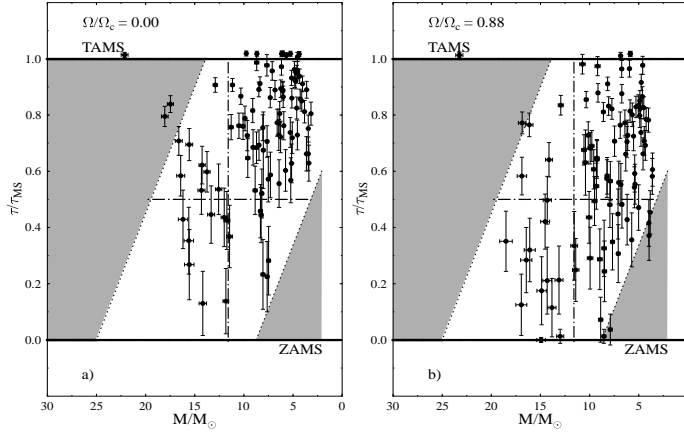


Fig. 1. Age ratios τ/τ_{MS} of the studied Be stars against the mass. a) Parameters derived using evolutionary tracks without rotation; b) parameters derived using evolutionary tracks with rotation

References

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